VII.—*On the* Rhizocephala, *a new Group of Parasitic Crustacea.* By Dr. Fritz Müller, of Desterro*.

[Plate II.]

Rathke's 'Beiträge zur Fauna Norwegens' close with the description of two animals, *Peltogaster Paguri* and *P. Carcini*, which, even on reading the admirable memoir, appeared to me to be the most remarkable of the whole collection, and have since claimed one of the first places in the series of animals which I desired to investigate for myself. For this investigation an opportunity was recently afforded me by the discovery of two nearly allied species; its results were partly so surprising and out of the circle of our ordinary ideas, that, in communicating them, it is really a comfort to me to know of the existence of the two allied forms on the European coasts, and to be able to refer other naturalists to these in order to test my statements.

The head of these apparent worms, which is inserted into the body of the host, emits roots like those of plants—hollow tubes which, being much ramified, cling round its intestines; and their brood holds a middle place between that of the Lernææ and Cirripedes. They therefore constitute a new section of parasitic Crustacea, to which I give the name of *Rhizocephala* from the above peculiarity. It is to be expected that in these Rhizocephala a rich mine of new forms will be opened up, as each of the two Crabs which I have hitherto been able to examine in large numbers nourishes a species. Unfortunately I am destitute of all means of determining these animals; but they will be easily recognized by future visitors to our coast without any detailed description. Almost under every stone they will find a blackish-green, smooth-clawed, and uncommonly nimble *Porcellana*, and scarcely less abundantly, a small *Pagurus*, which seeks shelter almost exclusively in the shells of a *Cerithium*.

The parasite of the *Porcellana* may be called *Lernæodiscus Porcellanæ*; and that of the Hermit Crab, *Sacculina purpurea*. I shall describe first the two sexually mature animals, and then their larvæ.

Lernæodiscus Porcellanæ (figs. 1–3) occurs pretty commonly, usually single, rarely two together, attached to one of the anterior segments of the tail of its host, and often completely fills the space between the tail and the sternum. It has the form of a fleshy and pale-yellowish flesh-coloured disk, which may be upwards of 10 millims. in breadth by a little less in length. In front and behind, the disk is deeply sinuous, and on each side divided into from five to seven lobes, the usually enlarged ex-

* Translated by W. S. Dallas, F.L.S., from Wiegmann's Archiv, 1862.

tremities of which are also frequently sinuous. On the dorsal surface of the disk, which is turned towards the tail of the *Porcellana*, there are often smaller prominences, similar to the above lobes, near the margin. On the ventral surface, which is turned towards the sternum of the *Porcellana*, the eye is first struck by the ovary (Pl. II. fig. 2, *b*), which occupies nearly the whole surface up to the origin of the marginal lobes, but has posteriorly a broad and shallow sinus, and anteriorly a narrow emargination dividing it halfway down, and dilated into a clavate form at the posterior end.

Below the ovary (nearer the ventral surface) and near the anterior margin of the disk, there lie two very considerable roundish or reniform glands (fig. 2, *c*), of that peculiar translucent appearance that so frequently characterizes the testes of the lower animals; their efferent ducts, which are at first narrow, but afterwards dilated, very thin-walled and difficult to trace, run backwards on their inner side. I suppose that they open at the hinder margin of the ovary in the brood-chamber, which will have to be mentioned immediately. Likewise under the ovary, and corresponding therewith in its outlines, but filling up the anterior notch, there stretches a cavity with delicate walls, containing a reddish transparent fluid: that it is a single cavity is evident when it contracts; in the extended state, one might be misled into assuming the presence of a network of tubes passing between the separate groups of eggs, issuing from a vesicle situated in the anterior notch of the ovary, the colour of the thin stratum of fluid over the more prominent eggs becoming almost imperceptible, and distinct only in the furrows between them.

In the posterior sinus of the disk there is a considerable orifice, surrounded by a notched margin (fig. 2, *a*), through which water is seen to flow in and out with an alternate extension and contraction of the body. It leads to a wide brood-chamber, the extent of which is most easily ascertained when it is inflated by means of a fine-pointed glass tube: it is then seen to occupy the whole dorsal surface, except the anterior notch of the ovary, and to extend into the marginal lobes, which are merely diverticula of it. The brood-chamber is usually found fully distended with eggs, which adhere especially to its outer wall, and are all of the same age. When they approach maturity, the margin of the disk appears more transparent, and finally the marginal lobes and back are covered with black points, from the eyes of the young brood, which swims out simultaneously. Two days after the swarming, I again found in one animal fresh ova, in course of complete segmentation in the brood-chamber. The water flowing into the brood-chamber serves, in my opinion,

only for the respiration of the eggs, which must pretty completely stop its access to the body of the mother. In many other Crustacea, also, the attachment of the eggs to the body of the mother may be necessary for the development of the brood, less on account of the protection thus afforded them than on that of the constant change of water; even nearly mature eggs of Crabs and Prawns separated by me from the body of the mother have always come to nothing, whilst the females kept in confinement have hatched with certainty.

In the anterior sinus of the disk is an arched chitinous shield (fig. 2 *s*) with concentric striæ, between which brownish-coloured particles are usually deposited. From its middle there springs a short neck, which pierces through the skin of the *Porcellana*. Within, it is surrounded by a strong chitinous ring, 0·2 to 0·3 mill. in diameter, which is continued into a serrated crown, dilated above, possessing a golden lustre. This crown is variously developed according to the age of the animal (*k*, figs. 2, 3). It is produced by the chitinization of the skin of the head. Single small chitinous lamellæ (fig. 3, *b*) are met with sometimes above the crown, beyond which the soft skin of the head extends but little. From the upper surface of the head, on which I found no trace of mouth, eyes, or antennæ, there issue numerous tubes (fig. 3, *w*), as much as 0·15 mill. in diameter, part of which, especially the outer ones, terminate cæcally at a very short distance, whilst the others, ramifying repeatedly, advance towards the intestine of the *Porcellana*, embrace this for a long distance, even into the thorax, and at last terminate in blind loops. Not unfrequently cords, more than 0·5 mill. in thickness, formed by the twining together of numerous separate tubes, are seen taking their course towards the intestine of the *Porcellana*. These roots, as they may be called from both their appearance and function, contain, in their delicate membrane, numerous fat-globules, which are distinguishable, by their much smaller and at the same time uniform size, from the fatty particles in the tail of the Crab.

That the roots are united through the neck with the large receptacle of fluid beneath the ovary is proved very simply and certainly by a circumstance which I was unable to explain before their discovery:—When the head of the parasite is removed from the body of its host, and sometimes even when the tail of the *Porcellana* is torn away from the thorax, an instantaneous and very striking pallescence of the *Lernæodiscus* takes place in consequence of the evacuation of the reddish fluid. Whether the cavity for the nutritive fluid, which can hardly be called the digestive cavity, commencing in blind roots, also terminates cæcally, I must still leave undecided, although a narrow process

often seen behind the orifice of the brood-chamber makes me think an aperture in this place not improbable.

I looked for males of *Lernæodiscus* the more zealously as Rathke observed in the brood-chamber of *Peltogaster Paguri* a small Crustacean, his *Liriope pygmæa,* but hitherto without any result. In the fluid obtained from the above-mentioned large glands I have, on the contrary, seen motile particles, the exact form of which my microscope is not capable of showing. From their mode of moving, I scarcely hesitate to regard the fluid as semen.

Sacculina purpurea (Pl. II. figs. 4 & 5), the parasite of our small Hermit Crab, appears to be no less plentiful than the *Lernæodiscus.* After my attention had once been directed to it, I could obtain from the shells collected during a single ebb-tide thirty or more *Paguri* with the parasite attached to them. The parasite adheres, in the form of a thick, slightly bowed cushion, of a purple-red colour, which was observed more than 6 millims. in length and half that thickness, to the base of the soft abdomen, and on its left and more convex side; its somewhat thicker posterior extremity, with the orifice of the brood-chamber, is turned towards the head of its host, and therefore towards the mouth of the shell. The point of adhesion is on the concave side of the cushion, rather nearer to the posterior extremity; from above, the extremities appear to be rounded-off in a spherical form.

The parasite is just as much obliquely twisted as its host. If we regard the concave surface, by which the animal adheres, as the lower one, and determine the posterior extremity by the presence of the aperture of the brood-chamber, then, of the two sides, which are distinguished beneath by the intestine and ovary, and on the back by a shallow furrow, the left is most developed posteriorly, and the right anteriorly. In front the difference is inconsiderable; but posteriorly it is so great, that the orifice of the brood-chamber is completely displaced towards the right angle of the posterior margin. This orifice forms a small longitudinal fissure, and exhibits the same currents of water as in *Lernæodiscus.* On the left side, the posterior margin runs out into a more or less distinct acute angle. The intestine and the ovary which lies over it form a rather narrow stripe, diminishing anteriorly and posteriorly, which extends from the point of attachment forward nearly to the anterior margin, and backward to the orifice of the brood-chamber. The whole remainder of the cushion is brood-chamber. The approaching maturity of the eggs is betrayed by a paler and more translucent coloration.

The concentrically grooved shield at the point of attachment

is but slightly developed; the golden crown in the interior of the host (fig. 6, *k*) differs from that of *Lernæodiscus* in that single broad branches issue from the ring, the wide ramifications of which gradually pass into the thinner skin of the head, whilst *Lernæodiscus* has acute and distinctly circumscribed teeth. The roots shooting from the head extend backwards upon the left side of the *Pagurus*, and form, between the hepatic tubes, a dense tuft of tubes springing from a few principal stems. From this tuft the hepatic tubes passing through it may easily be extracted, and it may thus be completely isolated (fig. 4 B, *w*). The colour of the tuft of roots is dark grass-green: it shines distinctly through the thin wall of the body of the *Pagurus*.

The larvæ of the two parasites have so many points of agreement, that I describe only that of *Lernæodiscus*, and shall merely call attention to the differences presented by that of *Sacculina*.

The larva of *Lernæodiscus* (fig. 6) is 0·2 millim. in length, 0·12 millim. in breadth anteriorly, and diminishes at first slightly, but in the last third more rapidly. At the posterior extremity it bears two short points. The slightly arched anterior margin runs out on each side into a short horn, somewhat bent backwards at the apex. The back is covered by a carapace which extends beyond the body in front and at the sides by 0·04 to 0·05 millim.; posteriorly it scarcely covers the origin of the two points, and also conceals only the base of the horns of the frontal margin.

On the lower surface there is, at a short distance from the anterior margin, a large, somewhat transverse eye, usually slightly emarginate in front, from which a strong nerve may be traced backwards, but which appears to be destitute of a refractive body. I cannot see the bristles at the sides of the eye to which Max Schultze has called attention in the young Cirripedia.

The point of origin of the three pairs of feet is situated nearly in the middle between the median line and the lateral margin; the foremost originates close behind the eye, the hindermost at the end of the second fifth of the length. The foremost has a thick cylindrical basal joint, and a short terminal joint with two long bristles; the second bears upon a thick basal joint a long outer (and anterior) branch with five, and a shorter inner one with three, long bristles; the third pair of feet is considerably shorter and weaker than the second; its outer branch bears four, and its inner one two, long bristles. The longer branches are annulated, but not distinctly jointed.

Between the feet of the middle pair there springs a triangular rostrum, with its apex directed backward. The wide intestinal canal, which advances forward a little beyond the rostrum, is still, during the first days, densely filled with brown yelk. Be-

hind the last pair of feet, a slight constriction of the body is sometimes to be seen.

The larva of the *Sacculina* differs in having a much larger carapace extending far beyond the frontal horns and terminal points, in the want of the eye, in the more oval form of the body, and in its straight frontal horns, directed obliquely forwards. I also found in it the bristles near the anterior margin, which are wanting in *Lernæodiscus*, and behind the last pair of feet on each side of the intestine an accumulation of brown opake granules (urine?), of which also I can find nothing in *Lernæodiscus*.

From the descriptions just given, the following peculiarities may be indicated as characteristic of the Rhizocephala, which hold an intermediate position between the Siphonostoma and Cirripedia :—

Crustacea Rhizocephala.

Larva with three pairs of natatory feet, of which the two posterior are biramose, with lateral frontal horns, two points at the extremity of the abdomen, and a membranous carapace. *Mature animal* soft-skinned, inarticulate, destitute of eyes, antennæ, feet, and mouth (?). Head immersed in the host, hardened at the base into a chitinous coronet, taking up nourishment by means of rootlike cæcal processes. Hermaphrodites with motile spermatozoids (?), without ovisacs (like the Cirripedia), and with a wide brood-chamber open posteriorly.

GENERA.

1. *Peltogaster*, Rathke*.
2. *Sacculina*. Body unsymmetrical, sausage-shaped; head in the middle of the ventral surface. Larva eyeless, with two frontal bristles.
3. *Lernæodiscus*. Body symmetrical, disciform; head at the anterior margin of the disk. Larva with an eye, without frontal bristles.

EXPLANATION OF PLATE II.

Fig. 1. *Lernæodiscus* attached to the tail of the *Porcellana*; slightly magnified.

Fig. 2. A smaller specimen from the ventral surface, magnified 15 diameters : *a*, aperture of the brood-chamber; *b*, ovary; *c*, testes (?);

* After the lapse of more than fifteen years, the details of Rathke's descriptions have escaped me too thoroughly to permit my characterizing this genus, or even deciding whether *Sacculina* should not be united with it.

s, chitinous shield; *k*, crown. The soft part of the head is wanting.

Fig. 3. The portion of the *Lernæodiscus* which is situated within the *Porcellana*, magnified 25 diameters: *b*, chitinous lamellæ; *k*, crown; *w*, roots.

Fig. 4. *Sacculina purpurea*, magnified 3 times: A, from below; B, from the right side; *a*, *b*, *k*, as in fig. 2.

Fig. 5. The portion of the *Sacculina* situated within the *Pagurus*, magnified 15 diameters: *k*, crown; *w*, roots.

Fig. 6. Earliest larval state of *Lernæodiscus*, from beneath, magnified 180 diameters.

Fig. 7. Earliest larval state of *Sacculina*, from above, magnified 180 diameters.

BIBLIOGRAPHICAL NOTICES.

Manual of British Botany. By Charles Cardale Babington, M.A., F.R.S., F.L.S. &c., &c., Professor of Botany in the University of Cambridge. Fifth Edition, with many additions and corrections. London: Van Voorst, 1862.

The 'Manual of British Botany' continues to maintain a steadily progressive character. Every page of the new edition bears witness to the industry and care of its author, and to his endeavour to keep pace with the advance of botany on the European continent. The Synopsis of Orders has been altogether remodelled, and is now arranged on the analytical or dichotomous plan so much used by French botanists. The descriptions of several of the more difficult genera and species have been re-written. Many improvements have also been made in defining the places of growth and range of the plants; and we meet with a welcome addition in the form of a glossary of botanical terms, which, like the accents now placed over the Latin names, will no doubt be found very serviceable.

Professor Babington thus announces his botanical creed:—"An attempt has recently been made greatly to reduce the number of our native species. The results seem to be so totally opposed to the teaching of the plants themselves, and the evidence adduced in their favour is so seldom more than a statement of opinion, that they cannot safely be adopted. Also, it has been laid down as a rule by some botanists that no plant can be a species whose distinctive characters are not as manifest in a herbarium as when alive. We are told that our business as descriptive botanists is not 'to determine what is a species,' but simply to describe plants so that they may be easily recognized from the dry specimen. The author cannot agree to this rule. Although he, in common with other naturalists, is unable to define what is a species, he believes that species exist, and that they may often be easily distinguished amongst living plants, even when separated with difficulty from their allies when dried specimens only are examined. He also thinks that it is our duty as botanists to study the living plants whenever it is possible to do so, and to describe from them—to write for the use of field- rather than cabinet-